Keywords: Taylor Spatial frame; Tibia fracture; Non-union; Malunion

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8B.5

The Ilizarov method for the treatment of segmental tibial fractures

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Introduction: The Ilizarov method and fixation is a well established treatment in lower limb reconstruction, but little has been reported about the outcome of its use in the treatment of segmental tibial fractures.
Aim: To review a single unit's experience of the Ilizarov method in segmental tibial fractures.
Materials and methods: 33 patients, aged 18–75 years, were reviewed retrospectively after the completion of treatment. 24 patients were male, 20 patients had open fractures; these were all graded as Gustilo–Anderson IIIb. Demographic data, type of fracture, period spent in the fixator, incidence of secondary operations and complications were recorded. The patients were asked to complete a Lysholm knee scale and Tegner activity level scale to assess knee function, an Olander and Moldeavia Ankle score to assess ankle function and a SF-36 health questionnaire.
Results: All fractures were united at the end of treatment; the mean time spent in frame was 181 days. In three cases of non-union occurred at one fracture site these were corrected with the application of a second frame. Malunion was reported in one case, this was corrected with reapplication of a frame and satisfactory union was achieved soon after.

Complications were few in number, one patient required excision of a ring sequestrum and one case of DVT was reported. There was no incidence of compartment syndrome.

The mean Lysholm knee score dropped from 91 to 58, the mean Tegner activity score dropped from 6 to 2, and the mean Olander and Moldeavia ankle score dropped from 95 to 55 before and after the fracture. The SF-36 scoring gave a mean PCS of 39 and MCS of 51.
Conclusion: The Ilizarov treatment of segmental tibial fractures can lead to relatively fast union rates, with an acceptably low incidence of complication. Due to the high velocity mechanism of injury the residual impairment of the limb is still significant.
Keywords: Tibial fracture; Segmental fracture; Ilizarov frame; High energy fracture

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8B.6

Management of paediatric tibial shaft fractures with the Taylor Spatial frame

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Introduction: The role of external fixation is well recognised in the management of paediatric tibial shaft fractures, especially those fractures involving the distal third, those associated with soft tissue injuries and in the multiply injured child. We have increasingly used the Taylor Spatial frame in the definitive management of these injuries and present our preliminary results.
Method and results: We evaluated retrospectively the outcome of 17 tibial shaft fractures treated with TSF over a 4-year period between 2004 and 2007. 12 of these fractures involved the distal tibia at the metaphyseal–diaphyseal junction. Although there were only 5 open fractures in this group, an additional 7 fractures had significant soft tissue swelling and bruising. Application of the external fixator was the primary treatment modality in 14 patients, but in 3 patients the fixator was the secondary treatment option, two of these following failure of closed reduction and plaster application, and one following the development of compartment syndrome after percutaneous K wire fixation. Three patients developed delayed union, two of who needed supplemental bone grafting to achieve union. The fixator was removed prematurely in one patient due to pin site infection, but the fracture went on to unite without any further complications. The mean time to union was 11.6 weeks (range 7.0–18.4 weeks) in patients who underwent TSF application as primary treatment, excluding the cases which went on to have bone grafting for delayed union.
Discussion: TSF is a versatile mode of external fixation in the management of paediatric tibial shaft fractures. Specifically it offers advantages over monolateral external fixation in stable fixation of distal fractures without spanning the joint, in allowing achievement of final reduction gradually and early weight bearing mobilisation. The mean time to union in our series is lesser than other studies where monolateral external fixation had been used.

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8B.7

Complications of elastic stable intramedullary nails in paediatric fractures

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This study aims to assess the incidence of complications of Elastic Stable Intramedullary Nails (ESIN) used to treat fractures in children. We reviewed all the elastic stable intramedullary nailing procedures carried out at a tertiary care paediatric hospital from 2001 to 2007.

A total of 176 cases (162 patients) were undertaken during this period. Case notes and X-rays of these patients were reviewed by three independent assessors.

There were 99 forearm fractures, 19 humeral fractures, 47 femoral fractures and 11 tibial fractures. There were 108 male and 54 females with a median age of 11 years (range 4–16).

Causes of injury included road traffic accidents (22), Sporting injuries (51), simple fall (78) and fall from height (11). Eight patients presented with open fractures. 129 patients had isolated limb injuries, whereas 13 had polytrauma with multiple injuries.

About 80% patients were operated within 24 h of injury. Open reduction was required in 35% cases, most commonly in forearm fractures (75%). Nails were removed after fracture union in all but 13 cases. All patients were followed up until the removal of the nails. Nine patients were lost to follow up. Mean time from insertion to removal of nails was 212 days (range 118–508 days). Median follow up was 7.5 months (range 3–20 months).

The complications found were skin irritation from prominent nail ends (32) all settled after removal of nails, loss of alignment in 12 cases (6 required further surgery), three non-unions and four transient nerve palsies.

Incidence of complications in diaphyseal fractures treated with Elastic Stable Intramedullary Nails is low. It is a safe procedure

for treating children's fractures, with minimal long-term complications.
Keywords: Elastic intramedullary nails; Paediatric fractures

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8B.8

A biodegradable scaffold for the treatment of a diaphyseal bone defect of the tibia

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Purpose: The aim of our study was to evaluate bone formation and angiogenesis produced within a biodegradable poly-D,L-lactide-co-glycolide acid / calcium phosphate (PLGA/CaP) scaffold when used to treat a diaphyseal tibia defect.
Methods: Canine tibiae were reamed to 7.0 mm and fixed with a 6.5 mm statically locked intramedullary nail after creation of an 8.0 mm diaphyseal defect. Eighteen canines were allotted into 3 treatment groups: (1) empty ($N = 5$), (2) iliac crest autograft ($N = 6$), or (3) PLGA/CaP biodegradable scaffold (Tissue Regeneration Therapeutics Inc., ON, Canada) ($N = 7$).

Fluorescent labels were given at 6, 9, 11 and 14 weeks. Animals were sacrificed at 15 weeks and perfused with a barium compound. Samples were analyzed with radiography, Micro CT, and brightfield and fluorescent microscopy.
Results: Bone and vasculature volume within the tibial defect site were reported as a percentage of the total volume of the defect site. The percent bone volume within the defect site was not different between treatment groups ($p = 0.112$). There was greater percent vasculature volume in the scaffold group than the autograft group ($p < 0.001$).

Bone formation at the osteotomy sites was defined as the distance from the original osteotomy site to the tip of newly formed bone. Osteotomy bone formation was significantly greater in the scaffold group than the autograft group ($p = 0.015$). Osteotomy sites associated with greater angiogenesis displayed greater bone formation.

Bone formation rates were reported as the distance between the fluorescent bone labels. Autograft samples had the greatest bone formation rates within the periosteum. Autograft and scaffold samples had the greatest rate of bone formation within the cortex.
Conclusions: Our canine tibial defect model provides a satisfactory facsimile of the traumatic tibia fracture with associated bone loss. The PLGA/CaP biodegradable scaffold we have employed promotes angiogenesis within a defect and could be used with autografting.
Keywords: Bone defect; Scaffold for bone; Tibia fracture; Bone substitute

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8B.9

Results of use of bone morphogenic protein-2 (BMP-2) in the treatment of long bone fracture non-union—A series of 25 cases

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Introduction: Bone Morphogenic Protein 2 (BMP-2) has been used as a bone substitute in various orthopaedic procedures including spine surgery and acute high energy open tibial fractures with bone loss. There were no reported series in the literature in the use of BMP-2 as the bone graft in the fracture non-union treatment. Our aim was to use BMP-2 in non-unions and to review the results.
Methods: We have treated 25 long bone fracture non-unions over a period of 2 years with BMP-2 during surgical fixation. We followed all the patients until union or failure requiring further surgery. Functional assessment was performed by short musculoskeletal functional assessment score (SMFA). 20 patients had BMP-2 only as the bone graft (group-1). 5 patients had iliac crest graft in addition to BMP-2 (group-2).
Results: There were 15 males and 10 females. Non-unions were spread across clavicle (4), humerus (3), ulna (2), femur (8), tibia (6) and lateral malleolus (2). 18 cases (90%) in group-1 and 5 cases (100%) in group-2 had clinical and radiological union. The mean time from original fracture to surgical intervention with BMP-2 was 15.21 months. Mean time from intervention with BMP-2 to further union was 7.43 months. There were no complications with use of BMP-2 either intra or postoperatively. The mean SMFA score has improved from 66.6 to 34.9.
Conclusion: BMP-2 may be an alternative to autologous bone grafting to avoid donor site morbidity in management of fracture non-union and can produce good results. Further studies with randomisation between autologous bone graft and BMP-2 will be required.
Keywords: Non-union; Fractures; BMP-2

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8B.10

BMPs and non-unions: A prospective randomised clinical study on 120 patients

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The purpose of this prospective randomised study, conducted between April 2005 and August 2007 at the Orthopaedic Institute G. Pini (University of Milan), was to compare the efficacy of recombinant bone morphogenetic protein 7 (rhBMP-7) and Platelet Rich Plasma (PRP) as bone-stimulating agents in the treatment of persistent fracture non-unions.

Long Bone NU is a very challenging condition that require adequate mechanical stabilization and often a concomitant biologic stimulation; to date, apart the use of Autologous Bone Graft (ABG) still considered the golden standard, Bone Growth Factors are available in clinical practice: recombinant human BMPs (rhBMP-7) or Autologous Growth Factors (AGFs) contained in Platelet Rich Plasma (PRP).

One hundred and twenty patients were randomised into two treatment groups (group rhBMP-7 vs group PRP). The number of males and females was 32 M–28 F for the rhBMP-7 group and 35 M–25 F for the PRP group. Sixty patients with sixty fracture non-unions were assigned to each group (median age: 46.4 ± 1.98 years for the rhBMP-7 group and 42.5 ± 1.76 years for the PRP group). Each patient underwent non-emergent operation for the treatment of their atrophic non-union, where adjuvant bone grafts were used according to the surgeon's preference. Revision of fixation method was implemented when deemed necessary.

In the rhBMP-7 group there were fifteen tibial non-unions, ten femoral, fifteen humeral, twelve ulnar, and eight radial non-unions. In the PRP group there were nineteen tibial non-unions, eight femoral, sixteen humeral, eight ulnar, and nine radial non-unions. The median number of operations performed prior to our intervention was 2.6 ± 0.62 and 2.7 ± 0.74 with autologous bone graft being used in twenty-three and twenty-one cases for the rhBMP-7 and PRP groups, respectively.